

Summary of Reviews of:
Consideration of Long-Term Climatic Variation in SFWMD Planning and Operations by
Obeysekera et al, June 4 2006

Rafael L. Bras, editor

Introduction

This document summarizes the independent reviews of the paper Consideration of Long-Term Climatic Variation in SFWMD Planning and Operation by Obeysekera et al, June 4, 2006. This summary is not intended to reproduce all the comments of the individual reviewers, which are publicly available. The editor's objective is to emphasize the main points of consensus as well as items that, in his judgment, are significant enough to warrant highlighting in this summary report. The readers are urged to consult the individual reports by Drs. Rafael L. Bras, John A. Dracup, James P. Heany, Gerald R. North and Eric F. Wood for additional comments and details.

As dictated by the charge to the reviewers the comments are organized by predetermined questions submitted by the SFWMD. The reviewers had no input on the formulation of the questions. Comments that do not fit a particular question are provided in a separate section.

Summary of Answers to Questions

Question 1: Has the District adequately addressed the long-term wet and dry cycles in modeling for a) facility planning, and b) operational planning. If not, what standard engineering practices can the District modelers follow to address climate variability due to indicators such as AMO.

The District is using appropriate tools and models and does a good job at arguing that the 1965-2000 precipitation and inflow series is representative of variability and extremes at the annual level. Nevertheless several key issues came out in the review:

1. The focus on AMO may be too limited and unwarranted. There are other important indices. In fact, the sense of the reviewers is that there is no evidence that the AMO effect is significant enough or known well enough *vis a vis* other major uncertainties that affect facility planning and operational planning: "the projected climate changes are relatively unimportant compared to other sources of uncertainty..." Some of the reviewers feel that issues of secular climate change and global warming be as important as or even more so than the AMO or other climate indices.
2. It is suggested by several reviewers that the emphasis on changes in mean levels of precipitation and inflows ignores the potential changes in variability of the hydrologic drivers.
3. The impact of the wet and dry periods on Lake Okeechobee inflows is not elucidated sufficiently. Seasonal effects need to be looked at more carefully;

- rainfall-runoff relationships are not clearly understood; the issues of changes on land surface use and operations in the upstream Kissimmee basin are not clarified.
4. One reviewer argues that facility planning requires specification of design criteria and that these are generally associated with quantifiable failure risks that in turn are associated with extreme events –wet or dry extremes. The reviewer points out that the report never shows that extremes with given probabilities of exceedance are never estimated from the design period data and hence it is not shown that the period in question is appropriate to capture whatever the design criteria is: i.e. does the period include the 100 year storm event?

Question 2: Is there compelling evidence that the volume of inflows to Lake Okeechobee will be as much as double during a wetter cycle as they were in a dry cycle? In the current modeling efforts, has the District adequately addressed the variability of inflows into Lake Okeechobee?

There is evidence that high lake levels and correspondingly high controlled outflows have occurred recently and in the past. That this is due to particular climatic oscillations is less evident.

It is clear that the issue here is one of seasonal variations, largely the months around the September-November period, and furthermore it is more an issue of inflows than of rainfall. The report could be far more focused on that issue. As will be repeated, the reviewers argue that rainfall from tropical storms and other origins should be analyzed independently. There is a sense that seasonal shifts in precipitation amounts, possibly caused by intense rainfall from unusual number of tropical storms may be part of the cause for the high inflows. Basin response to high intensity and short duration storms occurring over wet antecedent conditions can be very non-linear. At those times the natural storage capacity of the system is already used. If this is the case, it should be demonstrated with data and models. A comparison of the distribution of net inflows by month or season (not just annually like Figure 5) is needed. In summary, an explanation of the physical basis for the high inflows is not yet available.

The paper argues that the inflow anomalies could be due to changes in regulation in the Kissimmee basin but does not provide support for the speculation. One of the reviewers provides better evidence that changes in land use and regulation may indeed be a reason. This must be resolved. The paper also states that data inconsistencies may be producing spurious behavior but again does not back up the statement with sufficient evidence. One of the reviewers calls for better statistical analysis and more attention to distributional, or at least variability, changes.

At the annual level the distribution of inflows in the 1965-2000 period appears to cover the necessary range but again the information needs to be provided and discussed seasonally. The explanation for the “outliers” of Figures 6, 7 and 8 must be provided.

Question 3: Does the modeling approach used by the district for both CERP and WSE schedule design meet requirements of standard engineering and design practices. If not, what additional steps should the district take to improve modeling for these purposes?

Those familiar with the District's modeling capabilities feel that the approach and tools are appropriate. Nevertheless, the unfamiliar would have a hard time passing judgment. The quality of the modeling can only be as good as the quality of the input. The input is, after all, the important topic of the document. Was the input used representative of what may be expected in the future? Again, it seems that it is representative at the annual level. The reviewers generally feel that the AMO cycles are not necessarily the main issue nor consider it significant enough to use those cycles as predictive tools. But as stated earlier, the report lacks a convincing explanation of the observed high inflows, which must be better understood. The segregation of tropical storm rainfall is recommended. The argument is also made that the district should consider analyzing the response to extreme events with associated probabilities of recurrence. Similarly studying the sensitivity to variability of input is recommended. The value of ensemble seasonal forecasting should be investigated.

Question 4: Are the steps being taken in the adaptive management/modeling approach used by the District adequate to address the uncertainties in climate predictions and to assimilate new information?

The opinion of the reviewers is that adaptive management is a wise approach but that not enough information is given about what the district is doing for adaptive management. How is new information assimilated into the system? Is there enough flexibility to change decisions that may result of changing scenarios or state of knowledge? Given that we do not know enough about AMO or any other climatological cycle it is advisable to maintain the flexibility that adaptive management may provide.

Question 5: Except for basic research approaches, are there other facility planning options that the District should consider to address the possibility of continued wetter cycle?

The reviewers provide no alternative facility planning options. The majority feels that the tools used by the District are appropriate. One reviewer feels strongly that it is necessary to clearly specify performance standards for the various elements of the system and then measure any impact that unusual inputs, for example wetter or drier periods, will have on the performance of elements of the system relative to the standards.

The District has all the appropriate basic tools. Some of the report recommendations are appropriate responses to this question, particularly:

1. Continue to incorporate new climatological data
2. Investigate alternative methods to extend the modeling period backwards, prior to 1965
3. Refine the rainfall-Lake Okeechobee inflow relationships.

4. Continued monitoring and evaluation of climate and their impact on design, construction and operation of projects.
5. Use synthetically generated rainfall data to account for climate indicators.

In carrying out recommendation 2, it may be worthwhile to accept that going back in time will necessarily mean approximations but that the uncertainties of those approximations (i.e., missing spatial resolution) may be quantifiable and that the uncertainty could be propagated to the output.

Recommendation 3 must deal with understanding the seasonal behavior of inflows. What causes the unusual inflows and stages in the lake? You must be definitive about the impact of the management of basins upstream of the lake. The equivalent, but seasonal, version of Figure 11 of the main report must be obtained. The argument that the high points in figures 6, 7 and 8 of the main report are outliers is not defensible. The main point of the report is to explain that behavior.

Recommendation 5 is a good one but requires more analysis than presented. An unavoidable conclusion of the report is that differences in time periods are, whether due to climate oscillations or not, seasonal. They occur sometime near the end of the wet season, probably between August and November. Statistically, the differences seem to be marginal in precipitation and more significant in inflows during the months mentioned above. Based on the information available it is valid to wonder whether indeed this is an effect associated with tropical storms and hurricanes towards the end of the tropical storm season. This must be ascertained by separating the rainfall of tropical storms from that due to other mechanisms. The climatological analysis must be done for the potentially different populations. If there are different behaviors observed, then any synthetic generation of rainfall must take the two population differences into account. The District must also show that their rainfall-runoff modeling captures the response to large rainfalls and antecedent conditions properly.

Question 6: Are data and models used by the District appropriate (reasonable and adequate) for their intended applications?

The general opinion is that the models are appropriate for their intended applications. The focus of the report is the adequacy of the data used in the model, as it should be. Most reviewers feel that not enough is known about the use of climatic indices in forecasting inputs. There are other possibly more important concerns and uncertainties to resolve and quantify. The report is convincing that the 1965-2000 period spans the variability of precipitation well, even seasonally. It is less convincing in explaining the variability in seasonal inflows and the ability of the District's models to capture those seasonal inflows. Clearer evidence is needed that the model can reproduce the high stages in Lake Okeechobee corresponding to the periods of higher seasonal rainfall and that these were properly simulated for design and planning purposes. Given the seasonal storage in the system it is advisable that sequences of probable seasonal rainfall, synthetic sequences, be used to test the robustness of the designs (see answer to question 5 above).

Furthermore it is advisable to explore every possible avenue to extend the record precipitation and inflow record.

Issues/concerns which you feel MUST be addressed before this document can be published

The clarity of the report needs to be improved. References about and information on the models must be strengthened if the reader is asked to judge their adequacy.

The separation of tropical storms and hurricanes from the normal rainfall in Florida is necessary for analysis and modeling considerations.

The seasonality shifts in inflows to the lake are the least studied and the key to the conclusions. The reasons for increases in inflows must be understood.

Doing some sensitivity and uncertainty analysis is important.

The report does not offer information on the skill gained by using climate outlooks, either in the prediction of precipitation/temperature or in improved management.

The District should consider including a statement (and study plans) to evaluate how new climate change projections may impact facility planning and operation of the SFWMD. This would include changes in both 'normal' weather and tropical hurricanes.